ORIGINAL ARTICLE

Prolonged standing at work and hospitalisation due to varicose veins: a 12 year prospective study of the Danish population

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Background: Recent studies suggest that prolonged standing at work is associated with the development of diseases of varicose veins (VV).
Aims: To assess the risk of hospitalisation due to VV in the lower extremities prospectively in workers standing or walking at least 75% of their time at work.
Methods: A representative random sample of 9653 working age adults was drawn from the Central Population Register of Denmark in 1991. Of these, 8664 accepted to be interviewed by telephone (response rate 90%). Respondents (2939 men and 2708 women) were 20–59 years old and employed in 1990. Risk ratios for VV were estimated by log-linear Poisson regression models separately for men and women with adjustment for smoking status, body mass index (BMI), heavy lifting, and, for females only, number of children at baseline.
Results: During 12 years of follow up, 40 hospitalisations due to VV were observed among the men and 71 among the women. For employees with jobs that require prolonged standing or walking compared to all other employees, the relative risk was 1.75 (95% CI 0.92 to 3.34) for men and 1.82 (95% CI 1.12 to 2.95) for women. The pooled estimate of the relative risk was 1.78 (95% CI 1.19 to 2.68). The aetiological fraction of prolonged standing or walking at work was estimated as 22.5% for men and 22.6% for women.
Conclusions: This prospective study confirms that prolonged standing at work constitutes an excess risk of hospital treatment due to varicose veins and accounts for more than one fifth of all cases of working age.

A previous prospective Danish population based study hospitalisations due to VV[1] was based on data linked at an aggregated level and showed that the relative risk for VV among ''people who stand more than ¾ of their work-shift'' compared to the other employees was 1.85 (95% CI 1.33 to 2.36) for men and 2.63 (95% CI 2.25 to 3.02) for women. The study design allowed, however, only control for age, gender, social status, and smoking, and the latter variable was not controlled at the individual level.

Since the publication of this study, four recent cross sectional studies showed that standing at work is associated with a high prevalence of VV.[2–4] Laurika *et al* found an increased prevalence of self-reported VV among Finnish 40, 50, and 60 year old men and women mainly standing at work (OR 1.6; 95% CI 1.4 to 1.8).[2] In a recent German study, Kroeger *et al* found that both a predominately sitting posture at work and a standing posture at work were associated with the prevalence of self-assessed and clinically diagnosed VV (OR = 2.2; 95% CI 1.2 to 3.9).[3] A Croatian study of work conditions as risk factors for varicose veins of the lower extremities by Kontosic *et al* also showed a high risk of VV among those standing in the workplace (OR = 1.35; 95% CI 0.95 to 1.92).[5] Ziegler *et al* found that among 209 hospital workers, the 34% with chronic venous diseases were standing longer at work than their colleagues who were free of chronic venous disease, the ratios being 1.6 for men and 1.2 for women.[4 6]

We hypothesise that working in a standing position and/or walking (at least 75% of a regular shift) results in higher hospitalisation rates due to VV, even after adjustment for possible confounders.

METHODS

Subjects

In 1990, a representative random sample was drawn from the Central Population Register of Denmark. The sample contained 9653 adults aged 18–59 years. Of these, 8664 accepted to be interviewed by telephone (response ratio 90%). A series of questions about physical and psychosocial work environment, and lifestyle were asked, and the interview data were stored in a database often referred to as the Danish Work Environment Cohort Survey (DWECS).[7] The respondents who were employees in 1990, and 20–59 year old residents of Denmark in the beginning of 1991 (2939 men and 2708 women) are the subjects of the present study.

The Danish Data Protection Agency approved the project.

Data sources

The material of the present study consisted of person based data obtained through a record linkage between the interview database and three national registers—the central population register, the hospital register, and the employment classification module. The central population register contains information on gender, addresses, and dates of birth, death, and migrations for every person who has been an inhabitant of Denmark at some time since 1968. The unique civil registration number was used to link the various data sources. We had a 100% match. The employment classification module has existed since 1975 and contains annual information on socioeconomic status, occupation, and industry for each Danish inhabitant older than 16 years. The national hospital register has existed as a national register since 1978. It is updated each year and contains data on all treatments in Danish public hospitals (more than 99% of all discharges). In the time period 1978–93 the diagnoses were coded according to the International Classification of Diseases, version eight (ICD-8). Since 1994 they have been coded according to ICD-10. The basic units of observation in the register are, since 1977, discharges of day and night patients. Since 1995 the register also covers the conclusion of outpatient treatment courses and emergency ward visits.

Follow up and preparatory calculations

The study subjects were followed up for their first registered hospital contact with the principal diagnosis of varicose veins of lower extremities (ICD-8 = 454, ICD-10 = I83) in the time period 1991–2002. VV in the lower extremities as a complication to pregnancy (ICD-8 = 634; ICD-10 = O22.0) or the puerperium (ICD-8 = 671, 677; ICD-10 = O87.8) were not included in the case definition. However, a pre-test showed that respondents standing had 26% more children (95% CI 18% to 33%). To ensure that no confounding related to former pregnancies could confound the results we run the models with and without control for number of children. Dates of deaths, emigrations, and registered hospital contacts were used to calculate person-years at risk for each individual. Indirect standardisation was used to calculate an expected number of cases for each individual, which was adjusted for gender, and five year age group, with all employees in the total population of Denmark as standard population. The age pattern of morbidity in the standard population was thereby incorporated into the analyses as collateral information, and through that the power of our analyses was improved since we did not have to estimate any age parameters from our direct data set. More details on the traditions and principles behind the use of collateral data to improve power and precision are given by Hannerz.[8]

Statistical analysis

We used log-linear Poisson regression with the expected number of cases as an offset to estimate relative risks for varicose veins in the lower extremities as a function of the variable ''having a job that requires prolonged standing or walking (yes/no)'', and a series of background variables. The analysis was stratified by gender. As background variables we included smoking status (never smoker, ex-smoker, current smoker (<15 g/day), current smoker (⩾15 g/day)), baseline body mass index (BMI) in kg/m^2 (<20, 20–24, 25–29, ⩾30), and the occupational variable ''having a job that requires heavy lifting (yes/no)''. For the female population, we also included number of children at baseline (0, 1, ⩾2).

The variable about prolonged standing or walking was based on the question ''Does your work entail that you sit?'' which could be answered with one of the six reply categories: ''almost all the time'', ''approx. ¾ of the time'', ''approx. ½ of the time'', ''approx. ¼ of the time'', ''seldom'', and ''never''. A person was considered to be subject to prolonged standing or walking if his work seldom or never entailed sitting. The variable about heavy lifting was based on the question ''In your everyday work, do you lift loads weighing more than 20 kg?''. The response categories were the same as the ones given above. If a person's response indicated that he was exposed at least approximately ¼ of the time, then he was considered to have a work that requires heavy lifting.

We also calculated the aetiological fraction[9] of prolonged standing or walking at work for VV in the lower extremities. The following formula was used:

$$EF = \frac{p(RR-1)}{1+p(RR-1)}$$

where p is the proportion of exposed and RR is the risk ratio. The proportion of exposed in this cohort was used to estimate the proportion of exposed in the Danish working population.

Missing values

Sixteen of the observations among the men and 23 among the women were deleted due to missing values in at least one of the independent variables.

Validity of the basic information

The baseline questions have been used in many studies and have been validated on several occasions. Questions about duration of work postures like sitting and standing were found to have an acceptable agreement with observations in the Swedish ''MUSIC'' study.[10] The National Patient register has been validated in many studies, but unfortunately no studies have specifically dealt with VV. However, diagnoses related to surgery are in general found to have a high validity (agreement better than 90%).[11–14]

RESULTS

In total we observed 40 cases of varicose veins in the lower extremities among the men and 71 among the women. For employees with a work that requires prolonged standing or walking compared with all other employees, the adjusted relative risk was 1.75 (95% CI 0.92 to 3.34) among men and 1.82 (95% CI 1.12 to 2.95) among women. The pooled estimate of the adjusted relative risk was 1.78 (95% CI 1.19 to 2.68). The aetiological fraction of prolonged standing or walking at work was estimated to be 22.5% among men and 22.6% among women.

If five hospitalisations with VV diagnosed explicitly as pregnancy related are included in the model, the risk estimate for women changes to 1.62 (95% CI 1.01 to 2.58). All five pregnancy related VV hospitalisations were observed in women not exposed to prolonged standing at work. This explains the reduction of the risk estimate.

DISCUSSION

In this study we followed a representative sample of adult Danes for hospital treatment due to VV over a period of 12 years. This enabled us to analyse the association between standing at work and venous vascular disease prospectively while controlling for age, gender, smoking, heavy lifting, BMI, and number of childbirths. The results show a consistent, strong, and statistically significant relation between prolonged standing or walking at work and hospital treatment of VV for both men and women.

A higher inclination to seek hospital treatment among workers standing at work cannot be ruled out. Neither can we rule out the possibility that people of higher socio-economic status are more likely to seek help in private clinics outside the hospital system. If so, we may have overestimated the risk. We used hospital treatment as a proxy measure for the underlying incidence of VV. Studies using hospital treatment as the endpoint are often associated with referral or admission bias arising from social and geographical differences in the tendency to consult hospitals for medical care.[15–17] However, in Denmark, all health care is free of charge and a hospital can be promptly reached by any citizen. It was shown for hospitalisation due to ischaemic heart disease that lower grade hospital staff was the only occupational group that was subject to referral bias,[17] and we expect the same to be true for VV. It is known that circulatory diseases cause strong migration from heavy work into light work and out of work. For more severe VV this selection effect may also be strong. Our one year assessment of the occupation before the baseline of the 12 year follow up may have reduced this selection considerably, but still some remaining healthy worker effect may have biased our results towards unity.

The biological basis for the standing hypothesis is the impeded blood flow and consecutive stasis in veins of the lower extremities because of increased intravascular hydrostatic pressure in an upright working position. Stasis in the venous system is a key mechanism in venous vascular disease. Stasis increases the risk for coagulation and thrombus formation. The same mechanisms operate during walking, but probably to a

Table 1 Exposure to occupational and behavioural risk factors among employed Danish men and women in 1990 and relative risk (RR) and 95% confidence intervals (CI) for hospital treatment due to varicose veins* during 12 year follow up (1991–2002); results from Poisson regression

Variable and level	n (%)	Cases	RR	95% CI
Men	2939 (100)			
Prolonged standing or walking				
No	1797 (61)	21	1.00	–
Yes	1126 (38)	19	1.75	0.92 to 3.34
Heavy lifting (⩾¼ of working hours)				
No	2349 (80)	33	1.00	–
Yes	574 (20)	7	0.81	0.35 to 1.90
Baseline BMI				
<20 kg/m^2	97 (3)	1	0.96	0.13 to 7.15
20–24 kg/m^2	1707 (58)	24	1.00	–
25–29 kg/m^2	953 (32)	13	0.82	0.41 to 1.61
⩾30 kg/m^2	166 (6)	2	0.68	0.16 to 2.90
Smoking status				
Never smoker	944 (32)	13	1.00	–
Ex-smoker	557 (19)	9	0.89	0.38 to 2.09
Smoker (<15 g/day)	500 (17)	7	0.85	0.34 to 2.13
Smoker (⩾15 g/day)	922 (31)	11	0.69	0.31 to 1.55
Women	2708 (100)			
Prolonged standing or walking				
No	1729 (64)	35	1.00	–
Yes	956 (35)	36	1.82	1.12 to 2.95
Heavy lifting (⩾¼ of working hours)				
No	2384 (88)	61	1.00	–
Yes	301 (11)	10	1.16	0.59 to 2.31
Baseline BMI				
<20 kg/m^2	607 (22)	12	0.82	0.43 to 1.56
20–24 kg/m^2	1630 (6)	44	1.00	–
25–29 kg/m^2	361 (13)	11	0.98	0.51 to 1.91
⩾30 kg/m^2	87 (3)	4	1.32	0.47 to 3.71
Smoking status				
Never smoker	1042 (38)	29	1.00	–
Ex-smoker	438 (16)	17	1.41	0.77 to 2.58
Smoker (<15 g/day)	652 (24)	16	0.91	0.49 to 1.70
Smoker (⩾15 g/day)	553 (20)	9	0.57	0.27 to 1.20
No. of children				
0	721 (27)	12	1.00	–
1	497 (18)	10	0.90	0.39 to 2.10
⩾2	1467 (54)	49	1.21	0.64 to 2.30

Data regarding outpatients were included from 1995.
*ICD-8 = 454 or ICD-10 = I83.

lesser degree because the activation of the leg muscle pump during walking may reduce the venous stasis associated with an upright position as long as the venous valves are intact. Once the venous valves are incompetent, walking may actually increase venous pressure in the lower extremities because of a reversal in blood flow.

One may think that it is questionable to exclude pregnant women because they have to stand at work too, and in fact may be at an increased risk due to some interaction of pregnancy related and work related factors. Biologically, both conditions act through the same pathway: increased intravascular venous pressure (in the case of pregnancy, due to increased pressure on the abdominal veins into which the leg veins drain; in the case of standing, because of increased hydrostatic pressure). There were too few cases to investigate such interactions empirically. The exclusion of five women with VV due to pregnancy or the puerperium slightly increased the risk estimates because all five hospitalisations belonged to the reference risk category.

Additional studies should be designed to identify dose-response relations and threshold limits. Such studies should also include other disease outcomes associated with prolonged standing, such as low back pain[18] and arterial cardiovascular outcomes.[19 20] Follow up of men with VV in the Framingham study indicated that VV may be a risk factor for intermittent claudication and, at least in the lower social class, for coronary heart disease.[19] A recent prospective Finish study showed that rapid progression in carotid atherosclerosis was predicted by prolonged standing at work, giving rise to the hypothesis that haemodynamic changes associated with standing at work may play a role in both venous and arterial vascular disease.[20]

In line with Kroeger and colleagues,[3] but in contrast to our previous study,[1] we found that smoking may be associated with a low risk of VV, although RRs were not statistically significant. Smoking could be protective, most likely not per se but rather because smoking used to be a socially accepted way to get a break at many workplaces. Some of these breaks may also include the possibility to change to a sitting posture, probably even with the legs in an elevated position. An average smoker would have perhaps 5–7 such short breaks during working hours.

In conclusion, we found that predominantly working in a standing or walking position was associated with subsequent hospitalisation due to VV for both men and women. Our study is not detailed enough to establish a threshold limit for standing, but it suggests that standing or walking at work should be limited and alternate with other positions such as sitting, preferably with the legs in an elevated position.

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